PREFACE

In November 1969, the Intermountain Forest Pest Action Council acknowledged that the Douglas-fir beetle was causing extensive losses in timber stands and formed a special committee to explore immediate and long-range goals for combatting this pest. The council endorsed a cooperative administrative study by the Forest Service and Boyce Thompson Institute, Grass Valley, California, to determine if synthetic attractants, such as frontalin, could effect significant attraction of in-flight beetle populations.

It should be stressed, even though significant attraction was demonstrated in the 1970 pheromone study, that the use of bark beetle attractants on an operational basis is not recommended. It is planned to further pursue and refine baiting techniques using the attractant during the 1971 field season. These tests, if approved, will be conducted on the Boise National Forest.

1/ Composed of representatives from private, State, and Federal land management agencies.

ADMINISTRATIVE STUDY

THE USE OF SYNTHETIC FRONTALIN FOR MANIPULATING POPULATIONS OF THE DOUGLAS-FIR BEETLE

DESCRIPTION OF STUDY AREA

The frontalin administrative study site was located in the headwaters of Buck Creek, Atlanta Ranger District, Boise National Forest. This area lies within the Idaho Batholith which is characterized by coarse textured granitic soils. Study units were located on eastern aspect slopes that ranged from 10 to 100 percent. Mean elevation of the eight study units was 6,700'.

Douglas-fir, subalpine fir, and lodgepole pine were the main conifer species in the study area, with Douglas-fir predominating. Douglas-fir stocking averaged 55 stemps per acre with an average d.b.h. of 17.2". Volume per acre averaged 12.2 MBF (net).

For purposes of this study, the Boise National Forest negotiated the 6.140 MMBM Trinity Ridge Sale with Boise Cascade Corporation. Special provisions in the sale contract provided that no logging would take place in study areas until beetle emergence was completed. Also, it was stipulated that all study units would be logged in 1970 to prevent the possibility of baited infested trees remaining in place in 1971 and causing additional tree mortality. In addition, arrangements were made for loggers to fall infested study trees for sampling.

During the course of laying out the sale, eight of fifteen clearcut units were selected for study purposes. These study units comprised 172 acres and ranged in size from 11 to 34 acres (see map).

METHODS

The study plan called for bait and check trees to be spaced at two chain intervals along lines two chains apart. This design provided a grid of bait and control trees on two chain centers throughout each study unit. Lines were run as close to the contour as possible to facilitate ease of operation in the steep terrain.

Phase I -

On April 13, 1970, project personnel were helicoptered to preselected helispots to start selection and marking of bait and control trees. The only criterion set forth in selection of study trees was that they be 18" d.b.h. or greater. Study trees were marked on four sides with yellow plastic engineer's flagging tape. Two semi-permanent aluminum tags were stapled to each tree identifying unit, strip, and bait or control tree. Study tree selection, marking, and tagging was completed in the eight units on April 17, 1970.

Phase II

The next phase of the study was started on April 22, 1970, when bait and control caps were affixed to study trees. Polyethylene bait caps, 22 mm in diameter, had been preloaded with frontalin plus camphene by Boyce Thompson Institute personnel and were furnished in glass test tubes; 12 caps per tube.

Each cap contained approximately 1 cc of frontalin plus camphene mixture. Five bait caps were affixed to each bait tree by means of a wire clip. The same procedure was used on each control tree with empty caps. Wire clips were held with vise-grip pliers and the sharpened shank end driven into the bark. This left a protruding loop of wire into which the bait and control caps were snapped.

When this phase of the work was completed on April 25, 1970, frontalin-loaded caps had been affixed to 157 bait trees. One hundred fifty-four control trees received empty caps.

Phase III -

This phase of the study consisted of observing bait and control trees for attacks and recording all pertinent data. It was planned to start observations on May 18, 1970; however, heavy, late spring snows prevented early access to the study area.

During the first week in June, project personnel succeeded on gaining access to the study area with saddle horses and pack string. Snow depths in the study units varied from one to four feet, which made ground travel difficult. Due to these conditions, observations were only completed on five of the eight study units on that trip. Observations and data gathering on this trip, June 1-5, 1970, provided some interesting facts when all bait and control trees on units 11, 12, 13, 16, and 21 were examined. Seventy-four

of 89 bait trees were undergoing mass attack by the Douglas-fir beetle. Conversely, no check trees had been attacked. It appeared that adult flights had been in progress for approximately ten days.

From June 15 to 19, 1970, project personnel examined all bait and control trees on all eight units. At that time, 156 of the 157 bait trees were undergoing mass attack by the Douglas-fir beetle. In direct contrast to this, no attacks had occurred to the 154 control trees. The fact that 156 of 157 bait trees had been attacked with no control trees undergoing attack pointed out that synthetic frontalin was producing significant attraction of in-flight populations of the Douglas-fir beetle.

During the June 15-19, 1970, observational period, many downed Douglas-firs adjacent to bait trees in units 11, 13, 16, and 17 were examined for evidence of attack. These trees had been felled in early spring by high winds and under normal conditions would have been attacked by the beetle. Several downed trees were within ten feet of bait trees which were undergoing mass attack; however, the felled trees were not being hit. It was logical to assume that synthetic frontalin and the natural pheromone odors from attacking beetles were out competing the normally preferred attraction of the downed trees. These trees were kept under close surveillance and during the last week in June, attacks finally started taking place. It is interesting to note that during this same period, attacks were beginning to occur in trees immediately adjacent to bait trees.

On June 25, 1970, the Douglas-fir beetle had mass attacked 157, or 100 percent, of the preselected baited trees. One control tree was undergoing attack. On this date the objective of the study plan had been met.

Observations and data recording of study trees terminated on July 23, 1970. Thirteen of the 154 control trees, or 8.4 percent of the total, had been attacked. Table 1.

TABLE 1 ATTACKS TO BAIT AND CONTROL TREES BY UNIT AS OF JULY 23, 1970

Unit No.	No. Bait Trees	No. Bait Trees Attacked	No. Control Trees	No. Control Trees Attacked
11	18	18	15	2
12	22	22	23	2
13	12	12	11	2
16	11	11	12	0
17	20	20	21	1
19	14	14	14	2
21	26	26	24	2
TOTAL	157	157	154	13

Observations on June 15 and 16 showed increasing numbers of "slop-over" attacks occurring to Douglas-firs immediately adjacent to bait trees. This did not come as a surprise as workers have reported the same results in pheromone studies with other bark beetle species. These slop-over or adjacent attacks

provided the basis for gathering additional related data other than that set forth in the study plan. At this point, it was decided to collect as much data as possible in relation to adjacent attacks. These data were taken from June 15 through July 23, 1970.

A decision was made to establish one chain diameter plots around all bait and control trees. An inventory was made of all living Douglas-firs above six inches d.b.h. Also, distance from the bait or control tree was recorded along with compass direction (azimuth degrees). Data was gathered on a continuing basis throughout the 311 bait and control tree one-chain diameter plots. As data taking progressed, it became increasingly evident that considerable attraction was occurring in plots surrounding baited trees. Conversely, little activity was observed near control trees. Following is a resume of data taken from the bait-control tree plots:

TABLE 2

	BAIT TREES				CONTROL TREES			
Unit	Total ADJ Trees 33' Radius	Total ADJ Attacks	Cumulative DBH's	Ave. DBH	Total ADJ Trees 33' Radius	Total ADJ Attacks	Cumulative DBH's	Ave. DBH
11	114	77	1,576.4	13.8	85	12	1,256.0	14.8
12	93	51	1,605.8	17.3	113	3	1,813.4	16.0
13	98	78	1,379.2	14.1	72	3	1,105.3	15.3
16	63	24	972.7	15.4	55	1	839.6	15.3
17	58	33	1,033.8	17.8	90	2	1,309.4	14.5
19	57	30	887.6	15.6	31	1	493.4	15.9
20	235	119	3,442.2	14.6	214	4	3,132.4	14.6
21	102	68	1,451.5	14.2	85	1	1,295.1	15.2
TOTAL	820	480	12,349.2	15.1	745	27	11,244.6	15.1

58.5% of Total Adjacent trees attacked

3.6% of Total Adjacent trees attacked

Table 2 points out that a significant difference exited in attraction of the Douglas-fir beetle from bait to control plots. Over 58 percent of the green trees surrounding bait trees were attacked. Less than four percent of adjacent green trees within one chain of the control trees were attacked.

Phase IV -

Provision was made to have professional sawyers fall study trees for sampling purposes. This work started the second week in July and was completed in mid-August.

As per the study plan, sampling was done at the 12-foot level. A one-square foot section of bark was marked out and chain saw kerfs made to the sapwood. This section was removed and number of starts (attacks) recorded. This was done on all bait and control trees that had been attacked. In addition, sampling for comparative attack density purposes was done on fourteen trees that were attacked under what was considered natural conditions. These trees were located in the same drainage but out of the study units. Table 3 summarizes these data.

TABLE 3 - ATTACK DENSITY/SQ. FT., AND HEIGHT OF ATTACK FOR BAIT, CONTROL, AND NATURAL ATTACKS

	BAIT TREES			CONTROL TREES			NATURAL ATTACKS		
Unit	No. Bait Trees	No. Starts Per Ft^2	Ht. of Attack In Ft.	No. Check Trees	No. Starts Per Ft^2	Ht. of Attack In Ft.	No. Natural Attacked Trees	No. Starts Per Ft^2	Ht. of Attack In Ft.
11	18	232	427	2	24	86	1	13	20
12	22	289	612	2	30	81	2	3	13
13	12	159	376	2	21	75	3	22	53
16	11	117	303	0	0	0	4	16	32
17	20	198	593	1	10	51	5	9	43
19	14	185	396	2	30	102	6	9	47
20	34	506	781	2	29	92	7	9	26
21	26	299	974	2	17	85	8	13	41
							9	16	46
							10	16	45
							11	8	44
							12	13	17
							13	9	28
							14	5	16
TOTAL	157	1,985	4,462	13	161	572	14	159	471
Ave.		12.6	28.4		12.4	44.0		11.4	33.6

DISCUSSION

From this study, it can be concluded that frontalin and host terpenes such as camphene are potent chemical messengers regulating the host selection pattern of D. pseudotsugae. This conclusion is supported by the fact that on June 14, 1970, 99.5% of the baited trees had been attacked, while only one of the 153 check trees showed signs of beetle activity. The few and scattered attacks which eventually occurred on check trees are interpreted as random events; however, it is not inconceivable that attractancy was being generated at 132' from the pheromone sources. It would be difficult to determine the effective perimeters of a pheromone source; however, larger diameter Douglas-fir within a 50-60' radius appear susceptible to attack.

In efforts to confine or further focus D. pseudotsugae on predetermined trees, it is important to be aware of two basic patterns of behavior apparently triggered by aggregating pheromones. First, the distribution of attacked trees is markedly clumped, or follows a negative binomial distribution. Under this circumstance, it would be much more effective to bait many larger-diameter trees closely spaced rather than in a systematic single-tree pattern as was done in this study. Rarely at the population level prevailing on Trinity Ridge would isolated trees be attacked. Second, deployment of synthetic pheromones on living trees may result in tree mortality in excess of what would have occurred in their absence, since dispersion mortality of flying beetles is apparently reduced.

Utilization of the chemical messengers frontalin and host terpenes in the management of the Douglas-fir beetle by the trap tree-harvest method is a distinct possibility. The biological effectiveness of these compounds and the simplicity of their deployment should encourage the development of a technique that might serve as a routine practice in Douglas-fir management. Studies must also be undertaken and completed which would allow us to predict what effect such a practice would have on Douglas-fir beetle population trends.

Management or manipulation of Douglas-fir beetle through baiting of natural hosts cannot always be practiced in areas of high use or value, such as parks or watersheds. In these areas it is desirable to reduce the impact of bark beetle activity without sacrificing living trees. Under these conditions, the technique of using attractive traps other than living trees becomes an alternative. Deadtrapping, i.e., where the beetles are killed shortly after coming in contact with the trap, has considerable potential in Douglas-fir beetle management. However, deadtrapping of Douglas-fir beetle populations is still in the formative stages. At present, investigations indicate that additional compounds may exist in the pheromone complex that may make the material considerably more attractive. In addition, considerable work and testing of improved dead traps need to be undertaken before full scale field trials are attempted.

Jerry A. E. Kucht

JERRY A. E. KUCHT
Zone Entomologist